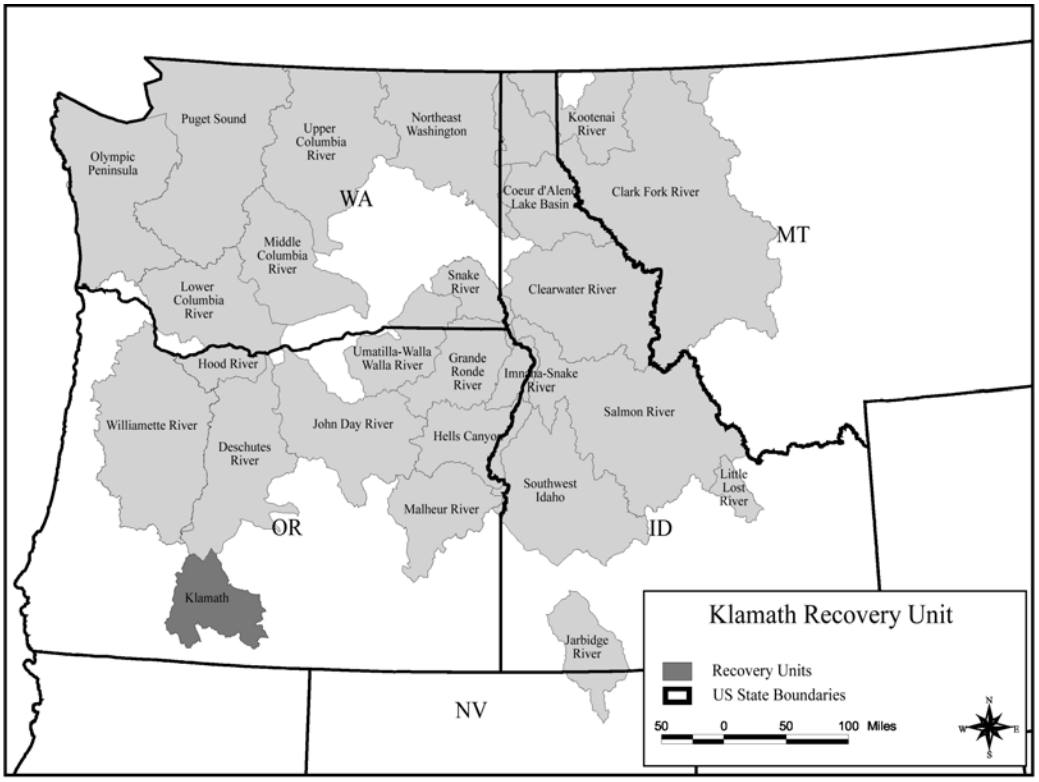
INTRODUCTION

Recovery Unit Designation

The Klamath River Recovery Unit (Figure 1) includes three distinct watersheds: the Upper Klamath Lake watershed, the Sycan River watershed, and the upper Sprague River watershed. These watersheds were included in a single recovery unit because bull trout probably functioned as a single unit historically.

Figure 1. Bull trout recovery unit in the United States. The Klamath River Recovery Unit is highlighted.



Status of Bull Trout at Time of Listing

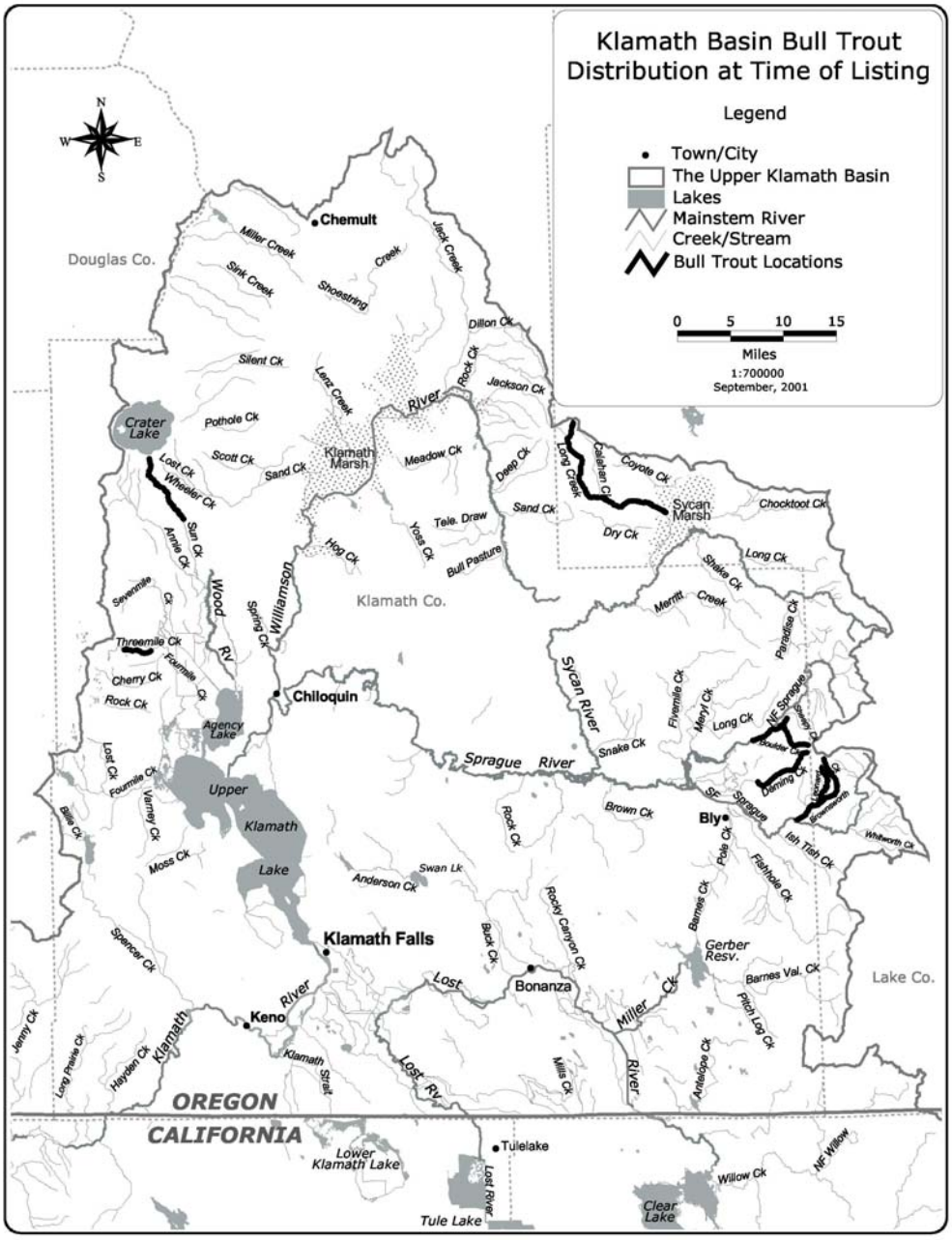
In the final listing rule (63 FR 31647), seven subpopulations of bull trout were identified within three watersheds in the Klamath River basin: (1) Upper Klamath Lake—Threemile and Sun Creeks; (2) Sycan River—Long Creek; and (3) upper Sprague River—Deming, Leonard, Brownsworth, and Boulder-Dixon Creeks (Figure 2). The Oregon Chapter of the American Fisheries Society (OCAFS) reported that almost 40 percent of the known Klamath River basin populations have been extirpated in recent years (OCAFS 1993).

Geographic Description

The Klamath River and its tributaries flow through a total of seven counties, two in southern Oregon (Klamath and Josephine Counties) and five in northwestern California (Modoc, Siskiyou, Trinity, Humboldt, and Del Norte Counties), before reaching the Pacific Ocean. The Klamath River basin consists of approximately 10 million acres and has its headwaters in south-central Oregon (ODFW 1997). Elevations vary from 840 meters (2,755 feet) in the Klamath River canyon at the state line to 2,894 meters (9,495 feet) on Mt. McLoughlin in the Cascades and 2,549 meters (8,364 feet) on Gearhart Mountain at the eastern edge of the basin. Most of the drainage tributaries funnel through Upper Klamath Lake, elevation 1,261 meters (4,140 feet), before spilling into Link River and Lake Ewauna at the head of the Klamath River (ODFW 1997).

The Upper Klamath Lake core area (Figure 3) is comprised of the lake and its immediate major and minor tributaries. The lake is the collection point for most of drainage tributaries, with a surface area of 37,260 hectares (92,000 acres). It is classified as hypereutrophic (or highly productive) (ODFW 1997). This core area incorporates the Upper Klamath Lake drainage, including waters draining from Crater Lake National Park south of Scott Peak and from the area west of and including the Williamson River below Klamath Marsh. Also included is the west

Figure 2. Distribution of bull trout in the Klamath River at time of listing.

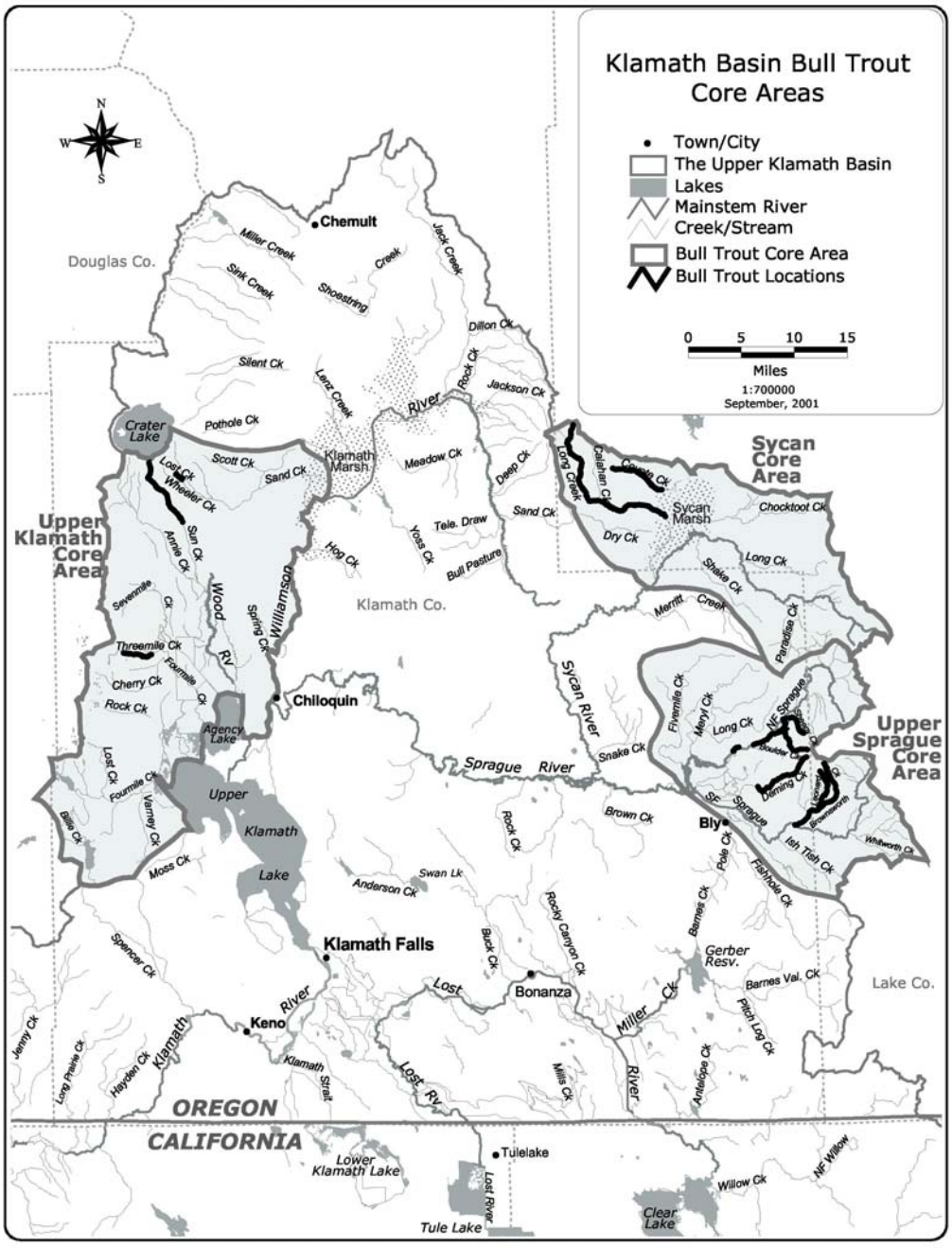


side of the Winema National Forest from Crater Lake National Park south into the Spencer Creek and Varney Creek drainages on the west side of Klamath Lake. This core area includes three existing local bull trout populations: Threemile Creek, Sun Creek, and Lost Creek. Sun Creek, in Crater Lake National Park, currently supports the largest local population in the Upper Klamath Lake core area. Major tributaries are the Williamson and Wood Rivers. Numerous small streams that are spring fed and surface water fed originate along the rim of the basin.

The Sycan River core area is comprised of the Sycan Marsh and its tributaries and the Sycan River and its tributaries. The Sycan River originates from springs near 2,133 meters (7,000 feet) on the eastern edge of the Klamath River basin. The river flows through high-elevation meadows and forest lands for 74 kilometers (46 miles). It flows through the Sycan Marsh for 15 kilometers (9.3 miles) from river kilometer 74 (river mile 45) to river kilometer 57 (river mile 36). Long and Coyote Creeks are tributaries on the west side of the marsh (ODFW 1997). After exiting the Sycan Marsh, the river flows through a variety of landscapes, including forested rim-rock canyons and open pasture land until it joins the Sprague River. This core area is composed of the waters that drain into the Sycan Marsh, including Long, Calahan, and Coyote Creeks on the west side of the marsh. On the east side of the marsh are the upper Sycan River, Chocktoot Creek, Shake Creek, and their tributaries. The largest local population in the Sycan River core area is found in Long Creek. Bull trout have been found distributed throughout the length of Long Creek and into sections of the Sycan Marsh. The Coyote Creek local population appears to be recently reestablished. Prior to presence/absence surveys in 1998, bull trout in Coyote Creek where thought to be extirpated.

The Upper Sprague River core area is comprised of drainages of the North and South Forks of the Sprague River. It begins 135 kilometers (84 miles) upstream of the mainstem Sprague River's confluence with the Williamson River. The origin of the North and South Forks are from small, mainly spring fed,

Figure 3. Map of Klamath River Recovery Unit core areas.



streams, near 2,926 meters (6,900 feet) elevation on the north and southeast sides of Gearhart Mountain. The upper few miles of each meander through high-elevation meadow and forest lands before being confined by narrow forested canyons (ODFW 1997). The lower stretches of the North and South Forks meander through the broad, low-gradient Sprague River valley. The Upper Sprague River core area is comprised of the drainages of the North and South Forks of the Sprague River upstream of their confluence, including Deming, Boulder/Dixon, Sheepy, Brownsworth, and Leonard Creeks. Deming Creek currently supports the largest local population of bull trout in the Upper Sprague River core area. Presence/absence surveys in 1998 discovered bull trout in the North Fork Sprague River below the confluence with Boulder Creek. Surveys also discovered bull trout in Sheepy Creek, where bull trout had previously been thought to be locally extirpated.

The climate of the Klamath River basin, the product of wind from the west and the Cascade rain shadow, varies from sub-humid to semi-arid depending on elevation (Weyerhaeuser 1995). Average annual precipitation ranges from 45 to 102 centimeters (18 to 40 inches), falling primarily as winter snow, with little rainfall during the growing season. While precipitation is generally greater in the higher elevations, much of the surface water for perennial streams is supplied by springs below 2,040 meters (6,700 feet). Runoff primarily consists of a base-level perennial discharge from springs and seasonal (mid spring) discharge from snowmelt. Rare rain-on-snow events may also occur in early fall or during spring snowmelt (Weyerhaeuser 1995). Growing seasons are typically dry with localized thunderstorms.

Temperatures vary widely both diurnally and seasonally. High temperatures at lower elevations may exceed 32 degrees Celsius (89 degrees Fahrenheit), while the low temperatures in upper elevations may drop below –30 degrees Celsius (–22 degrees Fahrenheit). Mean annual temperatures range from 8 degrees Celsius (46 degrees Fahrenheit) at lower elevations to 7 degrees Celsius (44 degrees Fahrenheit) at higher elevations (Weyerhaeuser 1994).

The upper Klamath River lies within the geologic provinces of the Cascade Range and the Modoc Plateau (USFWS 1997). The Cascade Range

extends northward through Oregon and Washington into British Columbia, and the Modoc Plateau extends into Oregon and southeastward into Nevada. The outstanding characteristics of the region are: (1) the dominance of volcanism and (2) the presence of broad areas of nearly flat basalt plains (USFWS 1997).

The Klamath River basin region of the Modoc Plateau supports some large and geologically old wetlands. The river systems of this area were once connected to both the Snake River drainage to the north and east and the Sacramento and San Joaquin drainage to the south. Bull trout streams in the Klamath River basin are located in three subbasins: (1) the Upper Klamath Lake subbasin, (2) the Sycan River subbasin, and (3) the upper Sprague River subbasin.

The Upper Klamath Lake subbasin is located on the eastern flank of the Cascade Mountains. These mountains are formed from basaltic andesites and pyroclastics and from volcanically derived sedimentary rocks that were formed by the activity of shield volcanoes during the Eocene period. After the volcanic activity, several glacial events carved and reshaped the topography. The glaciers were followed by a period of faulting. The eruption of Mount Mazama about 6,500 to 7,000 years ago blanketed the Cascade Range with pumice and ash.

The Sycan River subbasin originated during regional faulting events in the Pliocene Epoch. Volcanic layers of andesite and pumice formed the high lava plains in which these streams occur. The area has a bench-like appearance due to a set of resistant rock strata. These strata control channel location within the basin.

In the upper Sprague River subbasin, the dominant geologic feature is Gearhart Mountain, a dome-shaped shield volcano. The primary substrate is basaltic lava with localized rhyolitic lava also occurring. During past volcanic events, extensive lava flows formed the plateaus that basin streams cross in lower elevations.

Soils are typical of semi-arid eastern Oregon areas and are moderate to highly erodible (Weyerhaeuser 1994, 1995). Three soil groups with associated

vegetation influence the hydrology and channel characteristics: lower-elevation residual soils, upper-elevation pumice soils, and meadow soils.

Lower-elevation residual soils are derived from interbedded basalt, andesite, and tuff. Native vegetation includes ponderosa pine (*Pinus ponderosa*) communities and juniper (*Juniperus* species) communities (Franklin and Dyrness 1984).

Upper-elevation pumice soils are formed of Mazama ash and pumice overlying earlier eruptive andesitic and basaltic flows. They are often stony, containing boulders weathered from pillow lava. Native vegetation includes white fir (*Abies concolor*), pinemat (*Ceanothus diversifolius*), waxcurrant (*Ribes cereum*), lupine (*Lupinus* species), and Ross's sedge (*Carex rossii*) (Franklin and Dyrness 1984; Weyerhaeuser 1994, 1995).

Meadow soils have high clay content, formed from the weathering of former lacustrine deposits. Occurring over a wide range of elevations in low-lying areas where deep deposits have accumulated, these soils are dark, poorly drained, and remain saturated with water for much of the year. Plants associated with them are Kentucky bluegrass (*Poa pratensis* ssp. *agassizensis*), meadow foxtail (*Alopecurus pratensis*), California false hellebore (*Veratrum californicum*), rushes (*Scirpus* species) and sedges (*Carex* species). Springs are often associated with meadows (Franklin and Dyrness 1984; Weyerhaeuser 1994, 1995).

Fisheries Resources

Current fish communities are very different from those of the recent past. The Klamath River system once held large populations of shortnose suckers (*Chasmistes brevirostris*), Lost River suckers (*Deltistes luxatus*), and Klamath largescale suckers (*Catostomus snyderi*) (Buettner and Scoppettone 1990). The shortnose and the Lost River suckers are currently federally listed as endangered species (53 FR 27130). The drainage also supported chinook salmon

(*Oncorhynchus tswawytscha*) and steelhead (*O. mykiss*) (Fortune *et al*. 1966; Kostow 1995).

The Klamath River basin no longer supports the historic abundance of native fish species. Large populations of suckers no longer use the river. Runs of anadromous salmonids (chinook and steelhead) no longer exist because the Copco Dam, built in 1917, has blocked migration (Fortune *et al*. 1966). Planting of nonnative brook (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) has also altered the river's fish community (Weyerhaeuser 1995). Klamath Lake redband trout, the resident form of *O. mykiss*, persist in the Klamath River basin, and exhibit resident, fluvial, and adfluvial life histories (Kostow 1995). Although described from trout inhabiting Klamath Lake, the systematic classification of Klamath Lake redband trout from the lake and higher-elevation waters is unclear (Behnke 1992).

DISTRIBUTION AND ABUNDANCE

Current Distribution and Abundance

Since bull trout became listed as threatened in the Klamath River basin in 1997, the extent of known bull trout-occupied habitat has been expanded slightly, from seven to nine existing populations (Table 1). A local population of bull trout has been established in Lost Creek in Crater Lake National Park (Klamath Lake core area), and bull trout have been rediscovered in Coyote Creek (Sycan River core area), a local population formerly thought to have been extirpated. Additionally, several extensions of existing populations have also been discovered.

Upper Klamath Lake Core Area

As recently as the 1970s, bull trout were documented in Cherry and Sevenmile Creeks (Ratliff and Howell 1992; Light *et al*. 1996), although bull trout in both streams are thought to be extirpated. Surveys in 1990, 1991, and 1997 failed to detect any bull trout in Cherry Creek (OCAFS 1993; Buchanan *et al*. 1997; B. Quick, Oregon Department of Fish and Wildlife, pers. comm., 1999), and bull trout are also believed to be extirpated from Sevenmile Creek (Ratliff and Howell 1992; Buchanan *et al*. 1997). Bull trout have not been documented from the Wood River since 1938 (Dambacher *et al*. 1992).

In 1996, the Threemile Creek local population was estimated to be approximately 50 fish in a 1.4-kilometer (0.84-mile) reach (Buchanan *et al*. 1997) (Table 2), entirely within the upper drainage within Winema National Forest lands. Brook trout co-occurred with bull trout for 0.3 kilometer (0.18 mile) of this 1.4-kilometer (0.84-mile) reach (Buchanan *et al*. 1997).

In 2000, the results of an intensive snorkel survey of Threemile Creek indicated a population of at least 91 bull trout (KBBTWG, *in litt.,* 2000) in a 3.9-kilometer (2.4-mile) stretch. Recently, the Oregon Department of Fish and

Table 1. Summer distribution of bull trout and nonnative brown or brook trout in the Klamath River basin (adapted from Buchanan *et al*.1997).

Stream	Kilometers of bull trout only	Kilometers of bull and brook trout	Kilometers of bull and brown trout	Total kilometers
Boulder/Dixon Creeks	1.6	0.0	7.4	9.0
Brownsworth Creek	0.0	0.0	15.0 [a]	15.0
Deming Creek	6.4 [b]	0.0	0.0	6.4
Leonard Creek	2.2	0.0	0.5 [c]	2.7
Long Creek	0.0 [d]	23.2 [e]	0.0	23.2
Sun Creek	14.5 [f]	0.0	0.0	14.5
Threemile Creek	1.1	0.3	0.0	1.4
Totals	25.8	23.5	22.9	72.2

[a] In 1994, 2.3 kilometers of bull trout plus brown trout were estimated in Brownsworth Creek; however, this distribution was reduced to 0.3 kilometers in summer 1995 because only brown trout were found in the lower 2.0 kilometers. In 2000, bull trout plus brown trout were found down to the confluence with the South Fork Sprague River.

[b] In Deming Creek, 6.4 kilometers of bull trout are sympatric with native redband trout.

[c] In 1994, an estimated 1.9 kilometers of bull trout plus brown trout were in Leonard Creek; however, this distribution was reduced to 0.5 kilometer in summer 1995 because only brown trout were found in the lower 1.4 kilometers.

[d] In 1991, 2.8 kilometers of pure bull trout were in Long Creek. An invasion of brook trout recorded in 1994 reduced this distance to only 1.3 kilometers (Light *et al*. 1996). No reaches of only bull trout were recorded in 2000 (KBBTWG, *in litt*., 2000).

[e] In 1999 and 2000, surveys extended bull trout usage to the length of Long Creek. Radio telemetry indicates that bull trout also use portions of the Sycan Marsh. These fish may be either fluvial or adfluvial.

[f] Prior to 2000, 6.2 kilometers of bull trout plus brook trout were within the boundaries of Crater Lake National Park. In August 2000, brook trout were removed by application of antimycin.

Wildlife during a survey of private lands below the Westside Road did not encounter any bull trout and only a low incidence of redband trout (B. Quick, pers. comm., 2000).

The Sun Creek local population was estimated to be 133 adult bull trout (105 spawners) in 1989 (OCAFS 1993) in a 6.2-kilometer (3.9-mile) reach of Sun Creek, which is entirely within Crater Lake National Park (Buktenica 1997). During 1992 to 1994, annual estimates of bull trout abundance ranged from 120 to 260 fish (Buktenica 1997). In 2000, bull trout abundance was 635 fish for the

Table 2. Estimated abundance of bull trout, spawners, female spawners, and effective population size in six Klamath River basin streams (adapted from Buchanan *et al*. 1997).

Stream	Abundance [a]	Percent greater than 140 millimeters [b]	Spawner abundance (N) [c]	Percent females [d]	Female spawner abundance	Effective population (N_e) [e]
Boulder/Dixon	219	64	140	30	42	14-46
Brownsworth	964	46	443	30	133	44-146
Deming	1293	47	608	46	280	64-201
Leonard	834	25	208	33	69	21-69
Long	842	43	362	50	181	36-119
Sun	635	_ [f]	_ [f]	50	_ [f]	_ [f]
Threemile	91	61	45	50	22	5-15

[a] From Ziller (1992), Dambacher *et al*. (1992), Buchanan *et al*. (1997). Threemile Creek abundance is based on 3-pass snorkel surveys in 2000; Sun Creek abundance is based on 2000 nonnative removal project.

[b] Length of spawners assumed to be 140 millimeters or greater; may overestimate spawners because length of spawners in Sun Creek in 1947 was 160 to 184 millimeters. Percentage of length samples greater than or equal to 140 millimeters was estimated from Ziller (1992) and ODFW (1991, 1992) for Long Creek.

[c] Because length frequency data were not available, bull trout greater than 100 millimeters were assumed to be spawners, although this assumption probably overestimates spawners.

[d] Based on sex ratios in Rode 1990. An average sex ratio was used for Boulder and Brownsworth Creeks, and an estimated sex ratio of 1:1 was used for Sun and Long Creeks. Threemile Creek number of spawners is based on length frequencies for data from 1998 (50), 1999 (43), and 2000 (45).

[e] N_e was calculated by assuming that N_e/N ranges from 10 percent to 33 percent and that spawner abundance is an approximation of the adult population (Buchanan *et al.* 1997).

[f] Not available.

14.5 kilometers (8.7 miles) of stream within the National Park boundaries (M. Buktenica, Crater Lake National Park, pers. comm., 2000). In 1999, 119 bull trout were transplanted into Lost Creek in Crater Lake National Park to insure against loss of the original genetic stock during efforts to remove nonnative salmonids from Sun Creek.

Sycan River Core Area

Long Creek, a tributary of the Sycan River, has the only sizable population of bull trout in the Sycan River drainage. Buchanan *et al*. (1997) considered bull trout in the upper Sycan River to be "probably extinct". Several reports mention bull trout captured in the upper Sycan River as late as 1994 (Buchanan *et al*. 1997).

Bull trout are thought to be locally extirpated in Calahan Creek, Sycan River, and the South Fork Sycan River (Ratliff and Howell 1992; Ziller 1992; Light *et al*. 1996; Buchanan *et al*. 1997). The most recent capture of a bull trout hybrid in Calahan Creek occurred in 1993 (Light *et al*. 1996).

In 1998, presence/absence surveys discovered bull trout in Coyote Creek, were the fish was previously thought to be locally extirpated. Two bull trout and two bull trout/brook trout hybrids were observed (B. Quick, pers. comm., 1999). Because of the close proximity of Coyote Creek to Long Creek and because of the interconnectivity of canals and the Sycan Marsh, these fish probably originated from the Long Creek population.

In 1991, the Long Creek local population was estimated at 842 fish, with a spawning-size abundance of 362 adults (OCAFS 1993). In 1994, biologists estimated 855 bull trout in Long Creek. In 1995, the estimated bull trout population declined approximately 50 percent (approximately 400 fish) (Buchanan *et al*. 1997). Sampling in the 1990's indicated increasing numbers and multiple age classes of brook trout co-occurring with bull trout (Light *et al*. 1996). Population surveys in 2000 (KBBTWG, *in litt.,* 2000) led to estimates of 491 bull trout in the upper 3.4 kilometers (2.1 miles) of Long Creek. Population estimates are not available for the reaches below river kilometer 21.2 (river mile 13.2).

Prior to 1999, bull trout inhabited only the upper 3.4 kilometers (2.1 miles) of Long Creek. Buchanan *et al*. (1997) reported that Long Creek bull trout distribution had been reduced to the upper 1.3 kilometers (0.8 mile) of the drainage, a reduction in range of 1.5 kilometers (0.9 mile) since 1994. Presence/absence surveys in 1999 and 2000 indicated that bull trout are distributed in Long Creek upstream of the Sycan Marsh upstream for 23.2 kilometers (13.9 miles) (KBBTWG, *in litt.,* 2000). Within the Long Creek watershed, fish occupying the upper 2.8 kilometers (1.7 miles) are within the Fremont National Forest, while those within the lower reaches are on private land (U.S. Timberlands, Inc.) (Light *et al*. 1996).

Until 1998, only resident bull trout were thought to occur in Long Creek, although the capture of a 510-millimeter (20-inch) bull trout (Light *et al*. 1996) indicated the possible persistence of fluvial or adfluvial life history forms. In 1998, the observation of large fish up to 425 millimeters (16.7 inches) during presence/absence surveys and brook trout removal efforts further support the possible persistence of fluvial or adfluvial forms (J. Zauner, Oregon Department of Fish and Wildlife, pers. comm., 1998). In 1998, presence/absence surveys also found bull trout in downstream reaches of Long Creek that were previously thought to be uninhabited. Because downstream reaches of Long Creek and portions of the Sycan Marsh have not been surveyed or have been inadequately surveyed, bull trout distribution within this area may be more extensive than previously suspected. For example, bull trout were last documented in Coyote Creek in 1987 (Ziller 1992) and until recently were thought to be locally extirpated in this stream. During presence/absence surveys in 1998, however, bull trout were rediscovered in this stream (J. Zauner, pers. comm., 1998). In 1999 and 2000, radio telemetry studies indicated that larger bull trout use lower Long

Creek and parts of the Sycan Marsh during portions of the year (B. Quick, pers. comm., 2000), suggesting possible persistence of migratory forms in the Sycan Marsh.

Upper Sprague River Core Area

At the time of listing, only five streams within the Sprague River (Boulder, Dixon, Brownsworth, Deming, and Leonard Creeks) were occupied by bull trout.

During presence/absence surveys in 1998, three bull trout were observed in Sheepy Creek, an area where the fish were previously thought to be locally extirpated (B. Quick, pers. comm., 1999). All of these streams originate in the Gearhart Mountain Wilderness Area within the Fremont National Forest.

Bull trout summer distribution in Boulder and Dixon Creeks is 9.0 kilometers (5.6 miles) within the upper portions of these streams (total combined stream length approximately 11 kilometers [6.8 miles]). Bull trout co-exist with brown trout for 0.4 kilometers (.25 mile) of this 9.0-kilometer (5.6-mile) reach (Buchanan *et al*. 1997). Because of the proximity of Boulder and Dixon Creeks, the bull trout in these two streams are considered a single population. Previous population estimates (Table 2) placed bull trout abundance in Boulder and Dixon Creeks at 219 individuals. Presence/absence surveys in 1998 failed to detect any bull trout in Boulder Creek.

Because bull trout can range downstream in Boulder and Dixon Creeks to the confluence with the North Fork Sprague River, this area of the North Fork Sprague River may be occupied by bull trout during part of the year (Light *et al*. 1996). Observations of large (greater than 400 millimeter [15.7 inches]) bull trout during presence/absence surveys in 1997 (J. Zauner, pers. comm., 1997) and an angler report (R. Smith, Oregon Department of Fish and Wildlife, pers. comm., 2000) of a bull trout greater than 355 millimeters (14 inches) in 2000 indicate that fluvial fish may still persist in the North Fork Sprague River. Unlike for the Upper Klamath Lake and Sycan River core areas, no recent extirpations of local bull trout populations have been reported in the Upper Sprague River core area.

The largest population of bull trout in the Klamath River basin, approximately 1,200 fish, inhabit Deming Creek. Summer distribution in Deming Creek is 6.4 kilometers (3.8 miles) within this 17.3-kilometer (10.7-mile) stream (Buchanan *et al*. 1997). Deming Creek bull trout naturally occur with resident redband trout (Buchanan *et al*. 1997). During the summer, bull trout distribution does not extend below a water diversion structure at river kilometer 15.6 (river mile 9.4) where nearly all water is diverted. Deming Creek flows become subsurface flows approximately 0.6 kilometer (1.0 mile) below the diversion.

The Leonard Creek local population (about 830 bull trout) (Table 2) is distributed within the upper 2.7 kilometers (1.7 mile) of this 5.2-kilometer (3.2-mile) stream. Based on 1995 data, Buchanan *et al.* (1997) reported that between 1994 and 1995, bull trout distribution in Leonard Creek was reduced by 1.4 kilometers (0.9 mile).

Buchanan *et al.* (1997) reported that bull trout in Brownsworth Creek are distributed within the upper 3.1 kilometers (1.9 miles) of the 15-kilometer (9.3-mile) stream. In 1999, presence/absence surveys indicated that bull trout in Brownsworth Creek were only found for 8.3 kilometers (5.2 miles) upstream of the confluence with Leonard Creek (B. Quick, pers. comm., 1999). Population surveys in 2000, however, indicated that bull trout were distributed throughout the 15-kilometer (9.3-mile) stream, from the confluence with the South Fork Sprague River upstream to the headwaters (KBBTWG, *in litt.,* 2000).

In summary, the current abundance, distribution, and range of bull trout in the upper Klamath River basin are greatly reduced from historical levels. In the Klamath River basin, nine local populations of bull trout persist in only 82.2 kilometers (51.1 miles) of waters in three core areas. In the Upper Klamath Lake core area, bull trout are limited to 25.9 kilometers (16.1 miles) in Threemile, Sun, and Lost Creeks. In the Sycan River core area, bull trout inhabit 23.2 kilometers (14.4 miles) in Long Creek and appear to persist in part of the Sycan Marsh. In the Upper Sprague River core area, bull trout are limited to 33.1 kilometers (20.6 miles) in Deming, Leonard, Boulder, Dixon, Brownsworth, and Sheepy Creeks and in the North Fork Sprague River. Since the 1970's, bull trout have been extirpated from Cherry and Sevenmile Creeks and are thought to be extirpated from Calahan Creek, the lower Sycan River, and the South Fork Sycan River. Klamath Basin bull trout are threatened because local populations: 1) consist primarily of resident forms, 2) currently survive in fragmented and degraded habitats, 3) are at low numbers and have low reproductive potential, 4) are subject to interspecific competition and predation from brook and brown trout, and 5) hybridize with brook trout (Light *et al*. 1996).

REASONS FOR BULL TROUT DECLINE

Watershed disruption has played a major role in the decline of bull trout in the Klamath River basin. The effects of historical land use on fish habitat in the larger tributaries and mainstem rivers of the Klamath River basin have been profound (Buchanan *et al.* 1997). Channelization, water withdrawals, removal of streamside vegetation, and other disturbances have altered the aquatic environment by elevating water temperatures, reducing water quantity and quality, and increasing sedimentation (Light *et al*. 1996). Changes in or disruptions to watershed processes that influence characteristics of stream channels have also influenced the dynamics and persistence of bull trout populations. Klamath River basin bull trout are threatened by habitat degradation, past and present land use management practices, agricultural water diversions, and competition or hybridization from nonnative brown and brook trout (USFWS 1997; 63 FR 31647).

As a result of past land and resource management practices, bull trout populations in the Klamath River Recovery Unit are small and disjunct and face a high risk of extirpation (Dambacher *et al.* 1992; OCAFS 1993; Light *et al.* 1996; Buchanan *et al.* 1997). Based on the judgment of the recovery unit team, any land- or resource-related action in bull trout watersheds has the potential to significantly impact the species and its habitat. Additionally, land- and resource-related actions in historic but currently unoccupied habitat and in habitat that has the potential to support bull trout must also be considered to fully recover the species to a level at which it can be delisted.

Water Quality

Every bull trout stream in the Klamath River basin is identified in the 303(d) list of water quality impaired waters (ODEQ 1998). Water bodies included in this list do not meet standards developed under the Clean Water Act by the U.S. Environmental Protection Agency and the Oregon Department of Environmental Quality. Six of the seven bull trout streams identified in the 1997 listing exceed temperature standards established for bull trout (10 degrees Celsius [50 degrees Fahrenheit]). Threemile Creek is on the 303(d) list because of habitat modification.

Because the geology of the basin includes highly erodible soils, fine sediment is present to some degree in most of the basin's bull trout streams (Buchanan *et al.* 1997). In high-gradient reaches typical of streams presently inhabited by bull trout, gravel is not abundant, and its distribution is limited to small patches in depositional areas (Light *et al.* 1996). Spawning adult bull trout prefer sites where substrate is not highly compacted (McPhail and Murray 1979) and where fine sediments do not reduce the quality of spawning gravels.

In the professional judgment of the recovery unit team, elevated water temperatures and sedimentation are significant threats to long-term persistence of bull trout in the Klamath River Recovery Unit.

Dams

Passage at dams that may prevent bull trout from re-establishing connectivity within and between the three core areas will need to be addressed for recovery. Streams with dams and diversions that need assessment for fish passage have been identified in the *Klamath River Basin, Oregon Fish Management Plan* (ODFW 1997). Listed bull trout stream systems with dams or diversions include Deming Creek, the Sprague River (mainstem, North Fork, and South Fork), and the Sycan River, including the Sycan Marsh.

A single, small hydroelectric facility on the North Fork Sprague River, approximately 12.9 kilometers (8 miles) north-northeast of the town of Bly, Oregon, threatens fry and small juvenile bull trout with potential impingement and entrainment at the headstock. Terrain roughness and stream gradient and flow have prevented surveys of the canyon reaches above the facility. However, adult bull trout have been observed two miles above.

The water control structure located on the Williamson River in Chiloquin, Oregon, could become a potential migratory barrier if fluvial or adfluvial populations of bull trout are reestablished in the Upper Klamath Lake and Upper Sprague River core areas. The existing fish ladder is in poor repair.

Dams and water control structures do not currently appear to present a significant threat to bull trout in the Klamath River basin. However, in the professional judgment of the recovery unit team, the degree of threat posed by these structures will undoubtedly change as abundance and distribution of local and migratory populations of bull trout increase in response to recovery actions.

Forest Management Practices

Logging and road-building activities affect bull trout through increased sediment production and delivery to streams, loss of large pools, increased

temperatures, and loss of large woody debris. Low in-channel complexity and the loss of streamside vegetation have had significant impacts on bull trout and their habitat.

Surveys in bull trout streams in the Klamath River basin have shown that levels of fine sediments were moderate to high (Dambacher 1995; Light *et al*. 1996; Weyerhaeuser 1994). Quigley and Arbelbide (1997) noted that average road densities in bull trout watersheds were 0.28 kilometers per square kilometer (0.45 mile per square mile), a density considerably less than the 1.23 to 1.89 kilometers per square kilometer (2 to 3 miles per square mile) reported as adequate for other salmonids.

Past timber harvest practices have removed large trees from riparian zones outside of Wilderness and U.S. National Park boundaries. This tree removal has decreased shade and the availability of large woody debris, both important components of high-quality fish habitat (Light *et al*. 1996). Reduced shade resulting from timber harvest and close proximity of roads can be found along Dixon, Boulder, and Threemile Creeks (Dambacher 1995; Light *et al*. 1996). There may also be a strong correlation between increased temperatures and adverse effects of nonnative brook trout (Buchanan *et al.* 1997). For example, brook trout are more tolerant of warmer temperatures than bull trout are, and loss of shade has been linked to warmer stream temperatures (Howell and Buchanan 1992).

Large woody debris serves an important function in fish habitat. It creates pools, increases structural complexity, provides fish cover, traps gravel for spawning and for invertebrate production, holds other organic matter, and increases channel stability (Griffith 1993). In bull trout-occupied streams in the Klamath River basin, the abundance of large woody debris is considered moderate to low (Light *et al*. 1996; Buchanan *et al.* 1997). Past forest management often included removing large woody debris from stream channels in an effort to minimize culvert blockage and flooding. In Brownsworth Creek and the lower reaches of Cherry, Threemile, and Sevenmile Creeks, habitat complexity has been reduced by such stream channel clean-out. In the upper Sycan River drainage, large wood is lacking in portions of Paradise Creek, Watson Creek, and the lower Sycan River above the marsh (Light *et al*. 1996).

Pools are important summer and winter habitat for both adult and juvenile bull trout. Decreased pool frequency and increased bank erosion can result from land management practices, such as the reduction of roughness elements (large woody debris), or from natural disturbance. Lower-than-expected pool frequency is common within middle and lower reaches of most of the bull trout streams in the Klamath River basin (Weyerhaeuser 1994, 1995).

Stream shade is generally moderate throughout bull trout habitat in the Klamath River basin. Although low levels of shade can occur naturally in bull trout habitat, areas where reduced shade is the result of management activities (timber harvest, livestock grazing, and roads) are found in all managed watersheds. In some areas where riparian vegetation has been removed or suppressed, plant communities have been considerably altered.

In the professional judgment of the recovery unit team, the effects of watershed disruption (such as increased sedimentation, low channel complexity, loss of streamside and upland vegetation, decreased pool frequency, reduced large woody debris, and increased runoff) from past and current forest management practices are a significant threat to the long-term persistence of bull trout in the Klamath River basin.

Livestock Grazing

Cattle grazing has had a strong influence on riparian vegetation and stream bank stability in the Klamath River basin. Historical records from the Bureau of Indian Affairs and the U.S. Forest Service show heavy livestock grazing from 1911 to the 1950's (Buchanan *et al.* 1997).

Grazing in riparian areas has resulted in localized areas of decreased bank stability, increased sediment loadings, and removal of the vegetative cover that provides shade for most of the bull trout streams in the basin (Dambacher 1995; Light *et al*. 1996). Grazing appears to have resulted in the increased delivery of fine sediments in meadow areas like Long and Calahan Creeks. Surveys in Brownsworth Creek found some pool volume has been lost by filling with fine sediments (Weyerhaeuser 1995). Many streams in the North Fork Sprague River and upper Sycan River drainages are deficient in pools, especially large pools.

Although livestock grazing has been either eliminated or considerably reduced along most bull trout-occupied stream reaches, grazing and its associated impacts still occur upstream and downstream of known habitat and in historically occupied and potentially restorable drainages. In the professional judgment of the recovery unit team, the success of bull trout recovery in the Klamath River basin will be significantly impaired without curtailing or strictly managing livestock grazing in unoccupied and restorable habitat.

Agricultural Practices

Water withdrawals for irrigation are common features throughout the Klamath River basin. Agricultural diversions are present on four of the seven headwater drainages occupied by bull trout (Long, Deming, Threemile, and Sun Creeks) (Buchanan *et al.* 1997). Although these diversions are located downstream of bull trout-occupied habitat, they have altered stream courses and habitat, effectively reducing their suitability as bull trout habitat and contributing to habitat fragmentation.

A more direct consequence of water withdrawals exists where unscreened diversions can result in the transport of fish into irrigation canals and therefore to fish mortality. For example, in Deming Creek, depending on the season and demand, 100 percent of the stream flow may be diverted for agricultural purposes, resulting in dewatering of the natural channel and stranding of fish below the diversion.

Lower reaches of Threemile Creek flow through private property and have been diverted and channelized for agricultural purposes. These changes have resulted in habitat fragmentation, loss of riparian vegetation, elevated water temperatures, and habitat degradation.

Unscreened diversions and water control structures fragment habitat and isolate bull trout by creating barriers to fish movement. Below Crater Lake National Park, Sun Creek passes through State forest and privately owned lands. Once Sun Creek enters private lands, it is heavily channelized and diverted for agricultural purposes (Light *et al*. 1996). In addition, no diversions are screened. In the Sycan Marsh, water control structures may prevent bull trout from utilizing otherwise available habitat in the upper and lower Sycan River.

In the professional judgment of the recovery unit team, water control structures and agricultural diversions have contributed to the decline of bull trout in the Klamath River basin. Without ensuring adequate water flow, screens at diversions, and passage at water control structures, these structures will continue to impede recovery of bull trout in the Klamath River Recovery Unit.

Transportation Network

In roaded areas, culverts at road crossings are common barriers, limiting fish movement during some life history stages or seasons. Most culverts that affect bull trout in the Klamath River basin are found downstream of currently occupied habitat. Culverts in bull trout-occupied habitat that have been identified as barriers include U.S. Forest Service Road 3413-110 at Threemile Creek and the crossing of Brownsworth Creek by U.S. Forest Service Road 034 (C. Speas, Fremont National

Forest, pers. comm., 2001). Passage issues have also been identified on the North Fork Sprague River and on Yaden, Boulder, Cold, Dead Cow, Gold, and Sheepy Creeks (C. Speas, pers. comm., 2001).

An inventory of road/stream crossings conducted by the Fremont National Forest (C. Speas, pers. comm., 2001) has determined that nearly 80 percent of the culverts within the upper Sycan River drainage are barriers to fish movement. Nearly 161 kilometers (100 miles) of road, mainly those that are hydrologically connected and those within riparian habitat, need to be closed and/or removed (C. Speas, pers. comm., 2001) in order to improve watershed condition.

Bull trout are more streambed-oriented than other salmonids. The filling of boulder/cobble interstices with fine sediment reduces the gaps between cobble used by small fish in both summer and winter. Roads, including their building, maintenance, and use, affect bull trout through increased sediment production and delivery. Fine sediments can be reduced by decommissioning roads within riparian habitat and minimizing the effects on groundwater hydrology by those roads that must be maintained in the watersheds. U.S. Forest Service Road 3413, which parallels Threemile Creek, is a significant source of fine sediment. U.S. Forest Road 400, alongside Long Creek, has shown significant erosion into the stream. Other locations where fine sediment is a concern include the middle and lower reaches of Brownsworth, Leonard, Coyote, Calahan, and Deming Creeks.

Impassable culverts and increased sedimentation have contributed to the decline of bull trout in the Klamath River Recovery Unit. In the professional judgment of the recovery unit team, impassable culverts and other barriers to movement are a significant cause of isolation and fragmentation of habitat and of the loss of genetic exchange within and between local populations of bull trout. Increased sedimentation is a significant threat to survival of eggs, fry, and juvenile bull trout.

Mining

Mining of gravel from streams, for use in construction, has occurred in the Klamath River basin, but the extent to which this mining has occurred in bull trout streams is unknown.

Residential Development

Residential development has not been an issue in the Klamath River basin.

Fisheries Management

Introduced species (Table 3) also influence bull trout populations. Some introductions like kokanee (*Oncorhynchus nerka*) may inadvertently benefit bull trout by providing forage. Other nonnative species (*e.g.*, brown, brook, and lake trout) are thought to depress or replace bull trout populations (Dambacher *et al*. 1992; Ratliff and Howell 1992; Howell and Buchanan 1992; Donald and Alger 1993; Leary *et al*. 1993). Between 1926 and 1971, 275,000 brook trout were introduced into Sun Creek in Sun Meadow (above Sun Falls) and outside the Crater Lake National Park boundary. By 1989, bull trout abundance in the park was reduced to approximately 100 to 300 adult fish (Buktenica 1997).

Table 3. Nonnative fish species introduced into the Klamath River basin (ODFW 1997).

Coldwater Game Fish	Warmwater Game Fish	Nongame Fish
Brook trout (*Salvelinus fontinalis*)	Largemouth bass (*Micropterus salmoides*)	Fathead minnow (*Pimephales promelas*)
Brown trout (*Salmo trutta*)	White crappie (*Pomoxis annularis*)	Golden shiner (*Notemigonus crysoleucus*)
Lake trout *(Salvelinus namaycush)*	Black crappie (*Pomoxis annularis*)	Mosquito fish (*Gambusia affinis*)
Kokanee salmon (*Oncorhynchus nerka kennerlyi*)	Sacramento perch (*Archoplites interuptes*)	Goldfish (*Carassius auratus*)

Coldwater Game Fish	Warmwater Game Fish	Nongame Fish
Lahontan cutthroat trout (*Onchorhynchus clarki kenshawi*)	Bluegill (*Lepomis machrochirus*)	
White sturgeon (*Acipenser transmontanus*)	Pumpkinseed (*Lepomis gibbosis*)	
Domestic rainbow (*O. mykiss*)	Green sunfish (*Lepomis cyanellus*)	
	Yellow perch (*Perca flavescens*)	
	Brown bullhead (*Ictalurus nebulosis*)	
	Channel catfish (*Ictalurus punctatus*)	

Sex ratios from spawning adult bull trout in Deming and Leonard Creeks favored males (54 to 67 percent) with lengths of 140 millimeters (5.5 inches) or greater (Rode 1990). The average size of female spawners was small (175 millimeters [6.8 inches]), and fecundity averaged 170 eggs per female. Average fecundity of resident bull trout from Sun Creek in 1947 was 249 eggs, and females averaged 181 millimeters (7.1 inches) (OCAFS 1993). These data suggest that resident Klamath River basin bull trout have a low reproductive potential (Buchanan *et al.* 1997).

Hybridization with introduced brook trout is considered a serious threat to bull trout (Dambacher *et al*. 1992; Kanda *et al*. 1992; Leary *et al*. 1993). Life history differences between the two species, such as the higher reproductive potential of book trout, favor the brook trout and can lead to displacement of bull trout, especially when these differences are combined with habitat degradation (Hobbs and Huenneke 1992; Leary *et al*. 1993).

The occurrence of brook trout X bull trout hybrids has been clearly documented (Markle 1992; Kanda 1998). Dunsmoor and Bienz (*in litt.* 1997) observed that hybrids are aggressive, larger than resident bull trout, and may provide significant competition. The threat of hybridization and of hybrids replacing bull trout is probably greater where larger, more fecund migratory

forms of bull trout have been eliminated (Rieman and McIntyre 1993). In addition, interactions such as predation and competition are not well understood.

Brown trout, which are indigenous to Europe, were introduced to the Sprague River system in the 1930's (Weyerhaeuser 1995). Brown trout could be interacting with native fish in ways that may limit the native fish range and density in the watershed (Weyerhaeuser 1995). The likely mechanism for brown trout limiting native bull trout populations is by competitive exclusion. Evidence for this potential interaction is mainly from adfluvial bull trout in Montana and elsewhere (Leary *et al.* 1993; MBTRG 1996). The competitive advantage that brown trout have over brook trout has been demonstrated by several authors (Fausch and White 1981; Wang and White 1994). Generally, brown trout are more aggressive than native trout and can displace other native and nonnative salmonids. Brown trout may be better adapted to modified habitat with elevated water temperatures, providing them with a competitive advantage over bull trout (MBTRG 1996).

Displacement by nonnative salmonids has been recognized as an important factor in the decline of bull trout. The decline of native salmonids and their replacement by nonnative salmonid species has been extensively documented throughout the Intermountain West, including Idaho, Alberta, Montana, and California (Carl 1984; Weaver and White 1985; Rode 1990). A similar situation has been documented in the Klamath River basin (Ziller 1992), with brook trout and brown trout displacing bull trout. Upper Klamath River bull trout streams that have brook trout include Threemile, Sun, and Long Creeks. Brook trout are present in most streams formerly occupied by bull trout, including Cherry and Sevenmile Creeks. Brown trout are now found in many bull trout streams, including Boulder and Brownsworth Creeks and the Sprague River.

Although the Oregon Department of Fish and Wildlife has closed fishing for bull trout in the Klamath River basin and the use of bull trout streams by fishermen angling for other species is considered low (R. Smith, pers. comm., 1999; OSP, *in litt.,* 2000), illegal harvest could rapidly deplete local populations of bull trout in the Klamath River basin because population sizes are limited and

bull trout are particularly susceptible to angling (Carl 1984; Boag 1987). Current fishing regulations, with a 20.3-centimeter (8-inch) minimum length for trout (ODFW 1999), may not prevent take of spawning-size bull trout by anglers because they might not recognize the fish or some may disregard regulations. Angling can be a significant threat in streams with small populations of bull trout, such as Threemile, Boulder, and Dixon Creeks, where the removal of even a few spawning-age fish could significantly reduce the number of effective spawners.

Although fish identification posters have been placed alongside bull trout-inhabited streams in the Klamath River basin, the frequency of occurrence is low. The posters depict large migratory forms that are uncommon in the Klamath River basin instead of resident forms that anglers are more likely to encounter. Additionally, the inks used to print the identification posters are not colorfast and have faded, bleached, and changed color from exposure to the sun, making the identifying features of the fish difficult to decipher.

The threat from illegal angling is not currently considered significant. It does, however, have the potential of becoming a significant issue on bull trout steams that have small, threshold populations. While competition between bull trout and nonnative species has undoubtedly been a contributing factor in the decline of bull trout in the Klamath River basin, the level and complexity of threat is not well understood and is a subject for further research. In the professional judgment of the recovery unit team, hybridization with nonnative species is a very significant threat and has been a major contributor to the decline of bull trout in the Klamath River Recovery Unit.

Isolation and Fragmentation

Natural barriers to bull trout distribution (*e.g.*, high-gradient areas and waterfalls) are features of headwater reaches and occur most often at the upstream limits of distribution. Streams with stretches where flows become intermittent (*e.g.*, Cherry, Threemile, Boulder, and Hammond Creeks) present barrier limits or compress fish distribution during periods of intermittent or low flows. These effects vary depending on annual precipitation in these drainages.

Within the Klamath River basin, natural barriers that exclude nonnative salmonids from bull trout reaches are rare. Volcanic deposits have isolated Deming Creek fish from the rest of the Klamath River basin: the porous material allows water to flow below the surface, preventing fish movement. Although such a barrier has prevented nonnative species from invading the Deming Creek drainage, it has also prevented bull trout from expressing migratory behavior.

Extensive migrations are characteristic of bull trout. Connectivity between headwater streams allows genetic exchange to take place, for example, because bull trout can move during foraging, breed in different streams, and move into unoccupied habitat (Light *et al*.1996), the latter having occurred in Sheepy and Coyote Creeks.

Thermal limits to bull trout distribution may be a factor in several locations in the Klamath River basin. Lower-elevation streams may have not been hospitable for bull trout, even historically. However, sections of the North and South Forks of the Sprague River, uninhabited by bull trout now, were probably inhabited historically. The extensive wetlands of the Klamath and Sycan Marshes may have been marginal or intermittent habitat historically, but many tributary systems, as evidenced by Long and Coyote Creeks, were probably inhabited.

In summary, because bull trout populations in the Klamath River basin are small, isolated, and threatened with extinction, any land or resource actions leading to changes in or disruptions to watershed processes in occupied, historic, and potential habitat must be minimized in efforts to recover Klamath River basin bull trout to a level at which they can be delisted. Significant threats to the long-term persistence of bull trout in the Klamath River basin include sedimentation, low in-channel complexity, elevated water temperatures, competition and hybridization with nonnatives, barriers to movement, habitat isolation and fragmentation, and agricultural water diversions.

ONGOING RECOVERY UNIT CONSERVATION MEASURES

The Klamath Basin Bull Trout Working Group formed in 1989. It is composed of representatives from the U.S. Fish and Wildlife Service, Crater Lake National Park, Fremont and Winema National Forests, Klamath Tribes, Oregon Department of Fish and Wildlife, U.S. Timberlands, The Nature Conservancy, Oregon Chapter of the American Fisheries Society, PacifiCorp, U.S. Bureau of Reclamation, Sprague River Water Association, and Klamath Basin Water Users Protective Association. The working group developed, and has been implementing, a conservation strategy for bull trout in the Klamath River basin (Light *et al*. 1996). The goal is to protect and enhance bull trout populations throughout the basin.

The Klamath Basin Bull Trout Conservation Strategy has developed a two-phased approach to conserving bull trout. Phase I addresses biotic and abiotic factors that threaten the persistence of these populations. The presence of nonnative trout and of habitat degradation and alteration have been identified as the most immediate threats to bull trout within the Klamath River basin. Habitat enhancement is considered generally feasible, particularly in areas where roads or livestock grazing are threats. Suppressing and removing nonnative fish may prove difficult to sustain over time.

The intent of Phase II is to reestablish bull trout populations in headwater streams that now support nonnative trout only. Expanding bull trout into historical range will expand the number of local populations.

Recent conservation measures within the Klamath River basin (Table 4) have included: excluding cattle from stream riparian areas occupied by bull trout; surveying population and habitat; treating and obliterating roads near bull trout streams to control and eliminate sediment sources; and reducing timber harvest/woodcutting within riparian zones. Restoration projects by the Klamath Basin Bull Trout Working Group are also focused on reducing and eradicating nonnative species in native bull trout habitat.

Table 4. Completed, ongoing, and planned conservation measures of the Klamath Basin Bull Trout Working Group.

Conservation Measure	Status[a]
Bull trout sportfishing harvest in Klamath River basin closed (ODFW)	1991
Watershed analysis of Boulder Creek completed (U.S. Timberlands)	1993
Watershed analysis of Long Creek completed (U.S. Timberlands)	1993
Agreements made with U.S. Timberland to fence, remove, and exclude cattle from bull trout-occupied habitat	1994
Watershed analysis of Brownsworth Creek completed (U.S. Timberlands)	1995
Watershed analysis of Leonard Creek completed (U.S. Timberlands)	1995
Watershed analysis of Hammond Creek completed (U.S. Timberlands)	1995
Watershed analysis of Threemile Creek completed (Winema NF)	1995
Klamath Basin Bull Trout Working Group Conservation Strategy document completed	1996
Klamath Basin Bull Trout Working Group Coordinator hired	1996
Watershed analysis of Coyote Creek completed (U.S. Timberlands)	1996
Boulder Creek culverts replaced (U.S. Timberlands)	1996
Dixon Creek culvert replaced (U.S. Timberlands)	1996
Barrier enhancement project on Long Creek completed	1996
Genetic material from Klamath Basin bull trout populations collected	1996
Klamath Basin bull trout habitat evaluation surveys completed	1996
Boulder Creek road obliterated and seeded	1996
Bull trout watersheds in Winema NF designated as Tier 1 under National Forest Plan	1996
Road adjacent to Brownsworth Creek decommissioned	1997
Lost Creek (Crater Lake National Park) treated with antimycin	1997
Environmental assessment data collected from Threemile, Long, and Calahan Creeks (amphibian, macroinvertebrate, mollusks, water flow, and water quality surveys)	1998
Brook trout removed from fire pool/catchment in upper Threemile Creek watershed	1998
Sun Meadow (Crater Lake National Park) treated with antimycin	1998
Thermograph units placed in Threemile, Long, Calahan, and Brownsworth Creeks	1998
Fish regulation/identification signs placed	1998
Puck Lake connectivity survey conducted	1998

Conservation Measure	Status[a]
Deming Creek road decommissioned	1999
Bull trout radio-tagged in Long Creek	1999
Angling closed on Threemile Creek above Westside Road (ODFW)	2000
Genetic sampling done of bull trout in Threemile Creek and Sun Creek (Winema NF)	2000
Section 7 Biological Assessment done of Winema NF ongoing and proposed actions in bull trout watersheds (Winema NF)	2000
Removal of brook trout in Threemile Creek (electrofishing/snorkel/spearfishing)	Ongoing
Removal of brook trout in Long Creek (electrofishing/snorkel/spearfishing)	Ongoing
Analysis of Environmental Assessment data from Threemile, Long, and Calahan Creeks	Ongoing
Removal of brown trout in Brownsworth Creek	Ongoing
Presence/absence, distribution surveys on State, Federal, and private lands, including lower Threemile, Coyote, Sheepy, Brownsworth, Leonard, Dixon, Sun, Annie, and Sevenmile Creeks	Ongoing
Seasonal spawning ground surveys	Ongoing
Long Creek radio telemetry study	Ongoing
Habitat surveys	Ongoing

[a] Ongoing activities or the year the activity was completed.

An intensive program to remove brook trout from bull trout-occupied reaches of Threemile Creek has been ongoing since 1996. Brook trout removal was also initiated in Long Creek in 1998, and opportunistic removal of brown trout began in Brownsworth Creek in 2000. Also in 2000, bull trout in Sun Creek were captured and held in raceways while the stream was treated with antimycin to remove brook trout. Young-of-year fry were held in hatchery facilities until they grew large enough to be positively identified to species. Eighty-five were released back into their native habitat during 2001.

In addition to Threemile, Long, Brownsworth, and Sun Creeks, many other areas require removal of nonnative fish, including 1) tributaries to the Sycan Marsh and the upper Sycan River (*e.g.*, Coyote Creek) and 2) the North and South Forks of the Sprague River and tributaries (*e.g.*, Boulder, Dixon, and Leonard Creeks).

Although the Oregon Department of Fish and Wildlife closed angling for bull trout in the Klamath River basin in 1991 and angling usage in Threemile Creek appears to be light, the Klamath Basin Bull Trout Working Group has been concerned about the threat of incidental harvest on this population. In response to the working group's concerns, the Oregon Department of Fish and Wildlife closed angling on Threemile Creek in 2000, the best method to address the threat of incidental take on such a small population. The Winema National Forest is currently analyzing a proposed action to obliterate 3.2 kilometers (2.0 miles) of road paralleling Threemile Creek.

Oregon State Police angler surveys, especially those conducted during the hunting season when there is a higher incidence of angling taking place in conjunction with hunting trips, indicate that angling activity in the Klamath River basin is low to nonexistent (OSP, *in litt.,* 2000, 2001). Nevertheless, Oregon Department of Fish and Wildlife and the Oregon State Police, through the Cooperative Enforcement Program, continue to give Klamath River basin bull trout streams high priority for law enforcement patrol.